STAR Annual Safety Review

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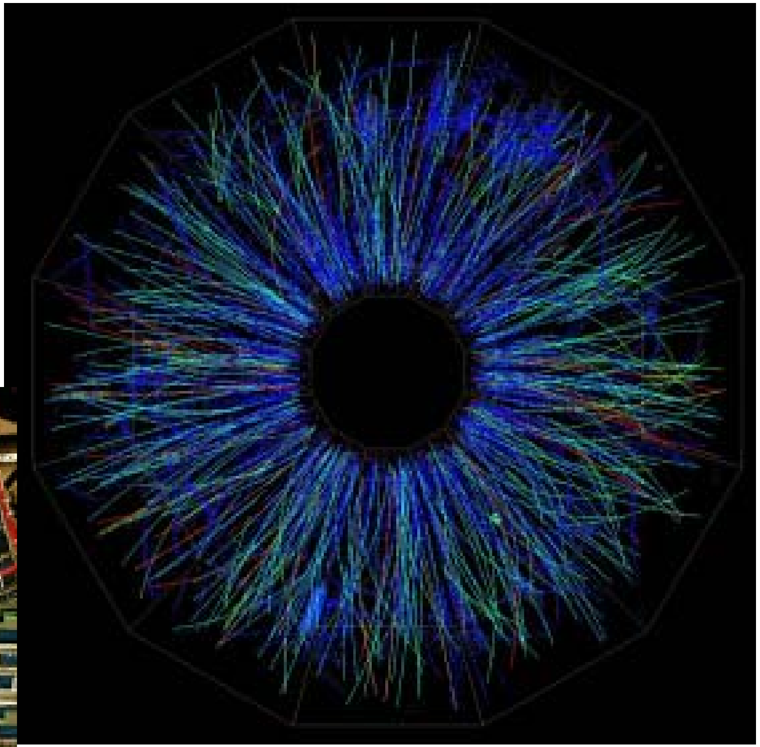
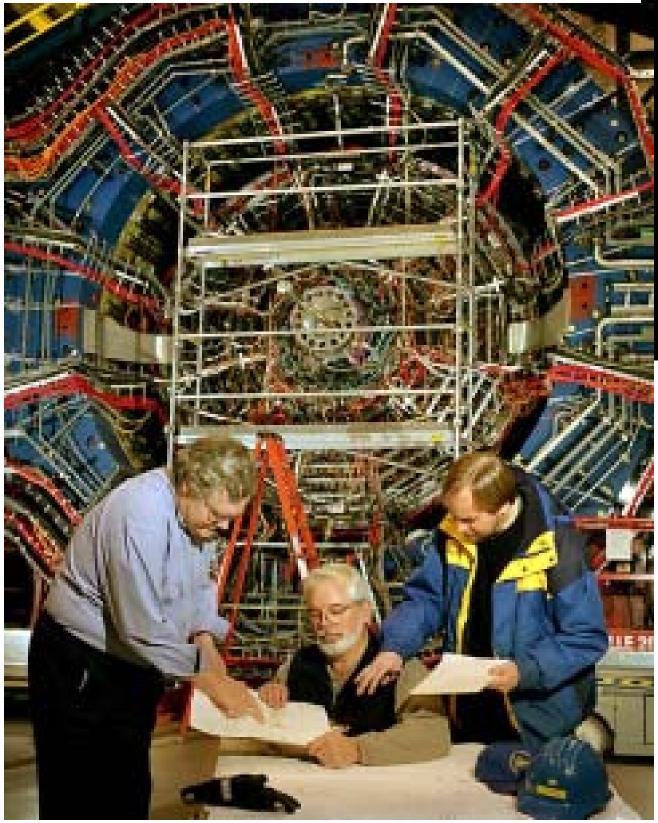
September x, 2004.

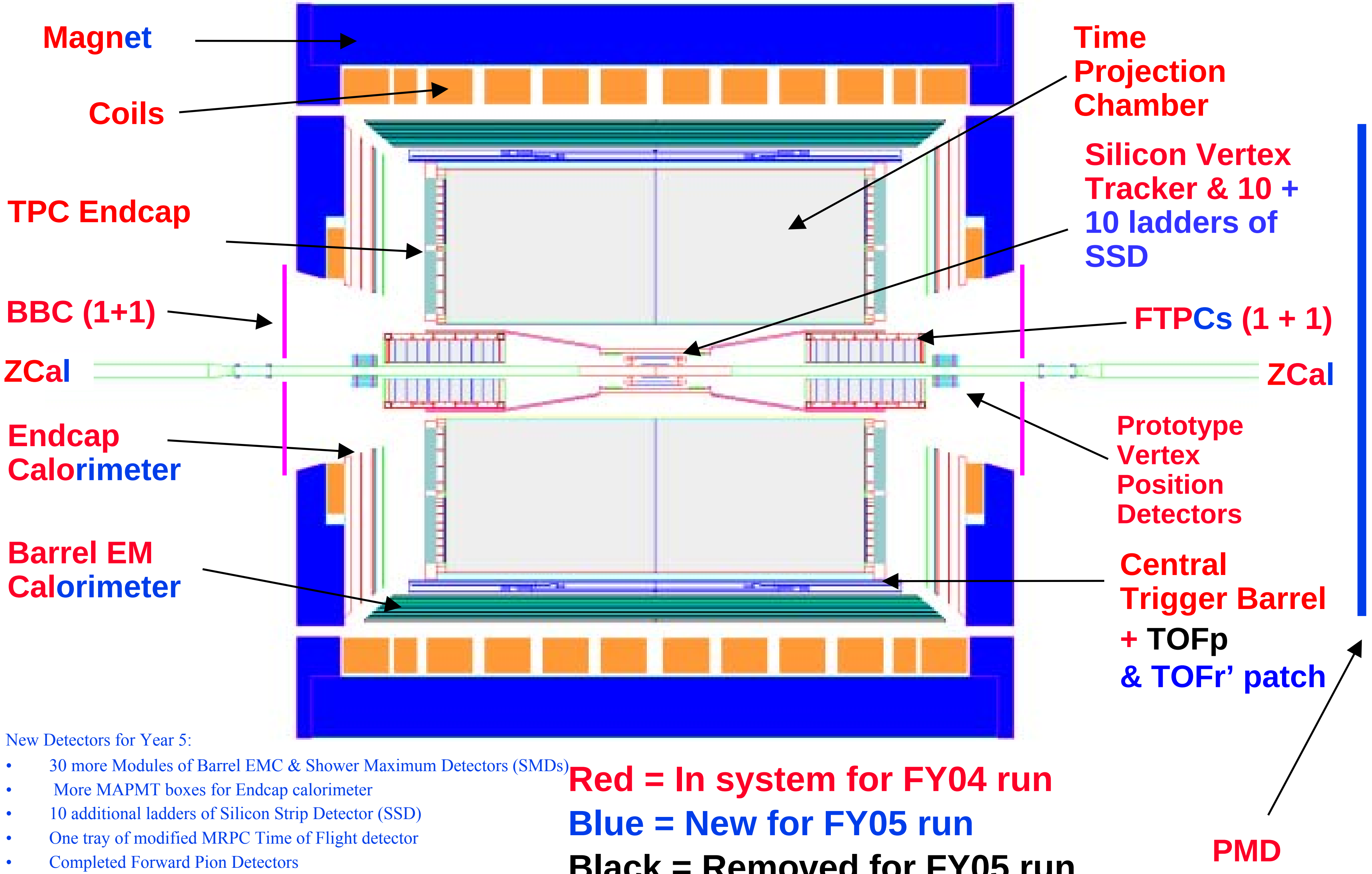


Outline

- The STAR Detector for Year 5
- Plan for Operations/shifts
- Walkthrough of Sub Systems
- Interlocks
- Summary



The STAR Detector for the FY05 Physics run



New Detectors for Year 5:

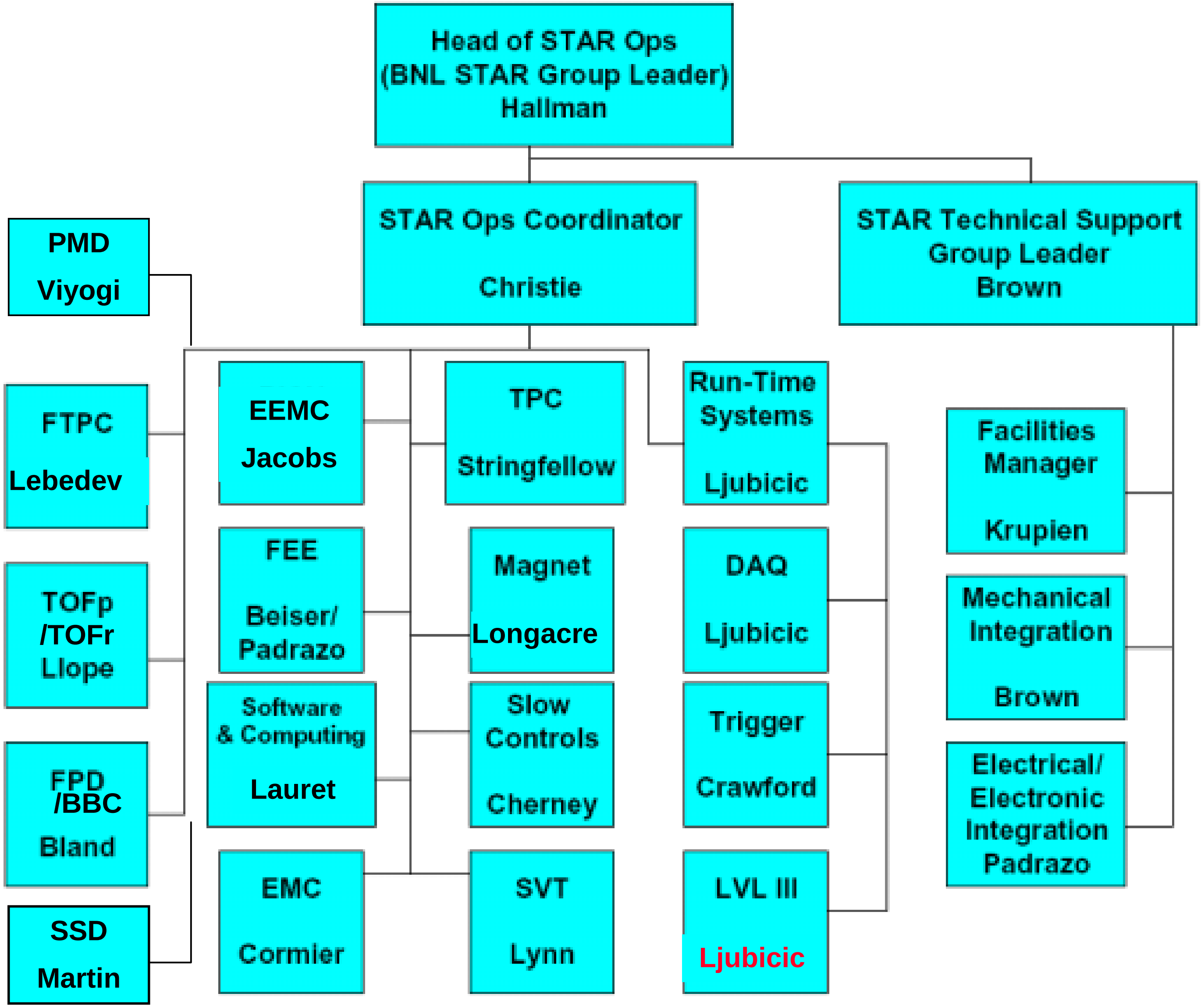
- 30 more Modules of Barrel EMC & Shower Maximum Detectors (SMDs)
- More MAPMT boxes for Endcap calorimeter
- 10 additional ladders of Silicon Strip Detector (SSD)
- One tray of modified MRPC Time of Flight detector
- Completed Forward Pion Detectors
- Veto for ZDCs

Red = In system for FY04 run

Blue = New for FY05 run

Black = Removed for FY05 run

Plan for Operations and Shifts



Plan for Operations and Shifts

- Shift Staffing Plan (No changes, worked well in FY04 run)
  - Shift Leader
  - 2 Detector Operators
  - Run Control/Trigger/On & Offline QA
    - Shift term will be 8 days (one day of overlap)
    - Shift crew will be stable (i.e. same set of people) for duration of shift

Sub Systems - Time Projection Chamber (TPC)

1. Configuration: Full TPC used

Small MWPC gain chamber mounted inside the TPC return gas manifold (west side at 12:00). Chamber has a 100 microcurie Fe55 source inside. HV is interlocked the same as the TPC.

2. Voltages:

TPC inner sectors	1170 V
TPC outer sectors	1390 V
Gain Chamber	1400 V
TPC Cathode	Up to 35 kV (nominal 27.0)
Gated grid	115 V with a swing of +-75 V
FEE & RDO power	+/- 8V

Two lasers with no exposed beams

3. Gas system:

Main TPC gas is P10 (10% Methane, 90% Ar)

Purge flow rate = 120 lpm for a total of 3 volume exchanges (TPC volume = 50,000 l)

Normal recirculating flow = 560 lpm with 14 lpm vented out the stack (stack located on the east wall of the STAR assembly building with the vent exit above the level of the berm retaining wall.)

Insulating gap gas is N2 - flow rate is 10 lpm out the vent stack.

N2 is also used in various places in the gas system, laser system and water system - total flow ~ 50 lpm vented to the room.

4. Water cooling - the TPC FEE & RDO are cooled by a closed loop water cooling system. Heat exchange is to the STAR MCW. Total volume is ~500 gallons and flow rate is 320 GPM. The system is located in the second floor utility room at STAR. No water is released to the environment.

5. Safety interlock: The TPC has an Allen-Bradley SLC interlock system. The main system is located in the gas mixing room, with a remote slave system located on the second floor south platform. The SLC is used for equipment protection, and is closely linked to the STAR SGIS. The TPC system provides interlocks and alarms for the TPC HV and LV. Adding small delays (~1 s) in kill signals, and adding surge suppressors to system.

6. No new procedures.

No changes for FY05 run.

Sub Systems - Silicon Vertex Tracker (SVT)

1. Configuration: Full SVT used

(3 barrels = 36 ladders = 216 wafers = 103,680 channels)

2. Voltages:

SVT high voltage 1500 V (fully enclosed, I < 9 mA)
FEE & RDO power +/- 8V
calibration voltages < 20V
One class 2 laser with no exposed beams

3. Gas system: no gas system

4. Water cooling:

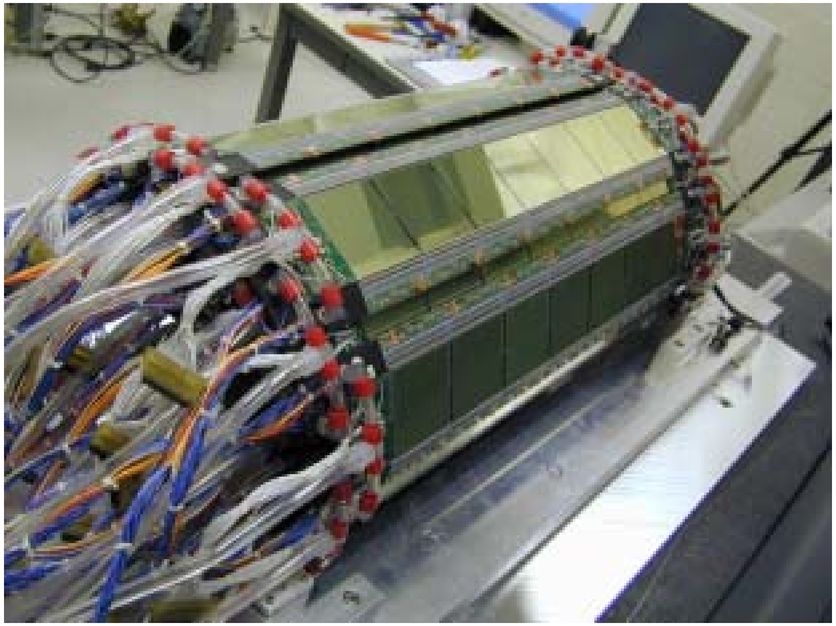
a.) the SVT front-end electronics (on-detector) are cooled by an independent closed loop water cooling system. Heat exchange is to the wide angle hall. Total volume is ~45 gallons, the volume of water in the system is 32 gallons. The maximum system pressure is 30 psig, however all elements inside the SVT are below atmospheric pressure. The nominal flow rate is 6 gpm at a nominal water temperature of 75 F. The system is located on the first floor of STAR North platform in the Wide Angle Hall. No water is released to the environment.

b.) the SVT RDO boxes are cooled by the TPC RDO closed loop water cooling system. The nominal flow rate through the RDO boxes is 12-19 gpm.

5. Air cooling:

a.) the SVT is air-cooled from outside the TPC wheel. An air manifold is mounted to the TPC wheel. The air is pumped into the SVT volume from the West Side and released to the Wide Angle Hall on the East Side. The operating pressure will be less than 0.8 in. H_2O (2 mbar). The shut off pressure is 2 in. H_2O (5 mbar)

The nominal temperature is 75 F and the maximum flow rate is 600 cfm (17000 lpm), however we expect much less.



Sub Systems - Silicon Vertex Tracker (SVT)

6. Safety interlock:

The SVT has a custom-made relay driven interlock system for equipment protection. The main STAR system is located on the STAR south platform (2nd floor). The system is closely linked to the STAR SGIS. The SVT system provides interlocks and alarms for the SVT HV and LV, plus RDO crate over temperature and the RDO water system flow and temperature. In order to turn on the SVT-LV the following permissions have to be granted:

a.) global (from SGIS) (requires tpc water flow, inner field cage air flow and all other global locks)

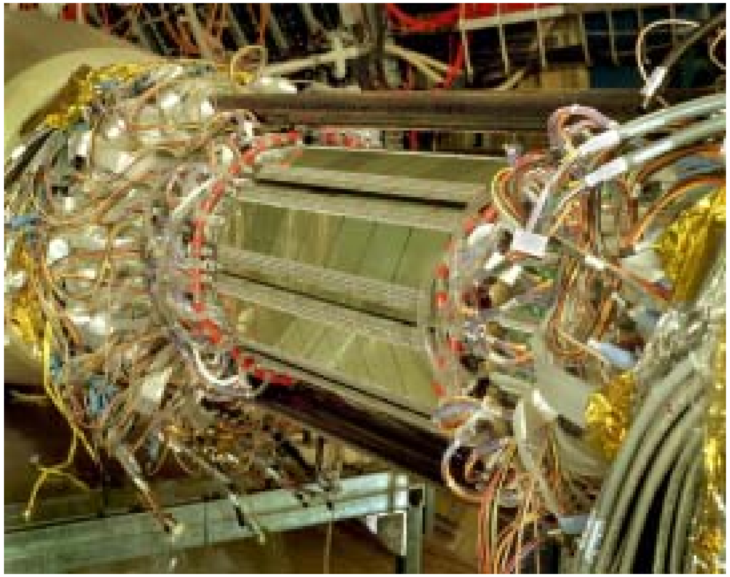
b.) no-leak (from trace-tek via TPC Allen Bradley) (requires no water leaks in any connected system)

c.) SVT water (from thermal dispersion flow switch located in svt water system) (requires SVT water is flowing)

d.) SVT water temperature (from temperature switch in svt water system) (requires that svt water temperature does not exceed 100 F).

e.) Water pressure less than zero. SVT water, power, and HV shutdown if water pressure is/becomes positive.

The SVT-HV can only be turned on if the SVT-LV is on.
The SVT leak detection is also incorporated into the STAR SGIS.
In case of a leak the SVT water pump will shut off.



7. No new procedures.

No Changes for FY05 Run

Sub Systems - Forward TPCs (FTPC)

1. Configuration:

i) Both FTPCs in the same configuration as for the previous run.
ii) 2 TPC lasers (class 4) used; no open beam

2. Voltages:

Anode voltage (readout chambers) :1750+/-50 V
Anode voltage (DVM) : 1200+/-50 V
Drift voltage (FTPC) : 12.5+/-.5 kV
Drift voltage (DVM) : 6 kV
Low voltage (FEE + RDO) : +/-8 V
Gating grid voltage : 180 V

3. Gas system:

Gas mixture: Ar/CO2 (50/50)
Purge flow: ca. 200 l/h and chamber
Operation flow: 50 - 100 l/h and chamber (in purge mode, will be higher in circulation mode)
Location: Gas mixing room
Exhaust to gas mixing room

4. Water cooling:

Water cooling for FEE and RDO boards
Supply system is closed circuit at low pressure (leakless) with heat exchanger to MCW
Total water volume: < 10 gallons
Flow: < 1.0 g/min
Supply system is located on 1. level on North platform
No water release to environment

5. Safety interlock:

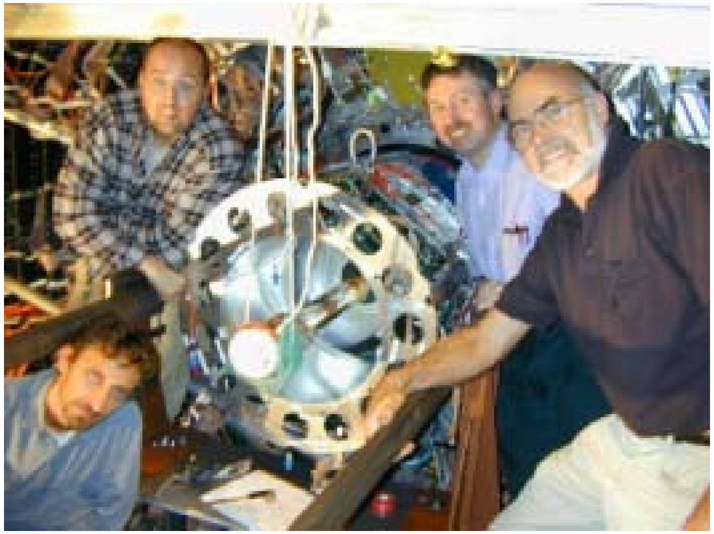
The FTPC interlock system is closely linked to the SGIS (Star General Interlock System) and the TPC interlock. TPC interlock outputs are fed into the FTPC system and are processed through a relay ensemble to control LV and HV. LV are also interlocked to the FTPC cooling system.

Under development, and expected to be operative before the run starts, are the HV interlock that inputs from the FTPC gas system and the cooling system interlock connected to the STAR water detection system.

6. Procedures: No new procedures for run 4.

7. Sub System Manager: Alexei Lebedev (BNL) will be taking over the role of Sub System Manager for the FTPC.

8. FEE protection Boards added: To protect the FEEs from failing at very high input charge rates "protection" boards have been inserted between the FTPC readout pads and the FEE input.



Sub System - Barrel EMC

1. Configuration: XX (of 120) EMC modules instrumented for the start of RHIC FY04 run period. The modules are arranged to give complete (360°) azimuthal coverage on the West end of STAR, and added coverage during the run on the East end of STAR.

3. Voltages:

EMC barrel PMT: 1470V fully enclosed and less than 10ma.

SMD wires: 1430V operating, 1500V maximum fully enclosed and less than 10ma.

FEE & RDO power: +/- 8V max.

No lasers.

4. Water cooling: The SMD FEE electronics are cooled by a closed loop water cooling system.

5. Safety interlock: The EMC has a relay based interlock system. A feed from the TPC interlock system includes water leak detection and HV and LV permissives from STAR.

EMC local interlocks include:

SMD water system flow and temperature

Crate power supply over voltage and overcurrent.

Crate over temperature.

SMD FEE over temperature.

6. PSD: Same architecture as SMD with PMTs in place of wire chamber. All HV fully enclosed, power and grounding like SMD. Uses RDO hardware identical to SMD.

7. Remote LV Power supplies for the BEMC Electronics crates: The LV power is supplied to the BEMC crates from supplies located in Rack row 2C on the South Platform. Implementation same as last year's remote LV test.

Barrel Shower Maximum Detector (SMD)

1. Configuration: 120 modules (complete system) and conventional systems for them installed.

Notes: SMD Modules require High Voltage, Gas Flow, Water Cooling and all grounds are electrically isolated from the EMC and each other.

2. Voltages:

HV supplied CAEN model SY1527. Caen supply is modular, multichannel with 4kv max per channel hardware limited to 1.5kv, 3ma/channel max, software limited to 5 uamp. SMD HV - 1430 V

3. Gas System:

Gas Bottles/Initial Supply Manifold located immediately outside door of gas utility room in STAR hall. Stepdown regulator located on third floor south platform of STAR Detector. Bubbler arrays located at 10 o'clock/2 o'clock West positions on backleg steel and West side magnet supports near 8 o’clock/4 o’clock positions.

SMD Gas is 90%Argon-10%Carbon Dioxide at low flow and atm. pressure.
Maximum Supply Pressure to Modules is 9 PSI

Pressure inside the SMD module -
12 mm H2O above atmospheric at nominal gas flow.
Total Gas Volume ~ 120,000 cm**3

Modules are ganged together in pairs, i.e. 120 modules = 60 pairs
Nominal Flow Rate - 10 cm**3/min /module
Total Nominal Flow rate - 1200 cm**3/ min

Gas is low flow, low pressure and non-hazardous.
Accidental overpressure of supply line (>50 PSI) vented outside building.
Gas is vented outside magnet thru system of bubblers into hall.
Gas Flow is monitored by remote TV cameras on array of bubblers.

4. Water Cooling:

The SMD FEE are cooled by a closed loop water cooling system.
Heat exchange is to the STAR MCW.
Total volume is ~ 1 liter, total flow rate ~ 100 cc/s.
Cooling water circuit supply/return rings on West end of Magnet. Cooling loop installed on East end of magnet.
Routing to detectors through plastic hoses with separate shutoff valves at 6 places around the ring on the West end of the magnet.
Water may be shut off at manifold on NorthWest floor level of STAR detector.

No water is released to the environment.

Supply Pressure = 110-120 PSI
Return Pressure = 23 PSI

All circuits pressure rated to 245 PSI @ 100F
Installed heat-exchangers tested to 150 PSI to UCLA, all circuits tested being installed to 110-120 PSI.

5. Safety Interlocks:

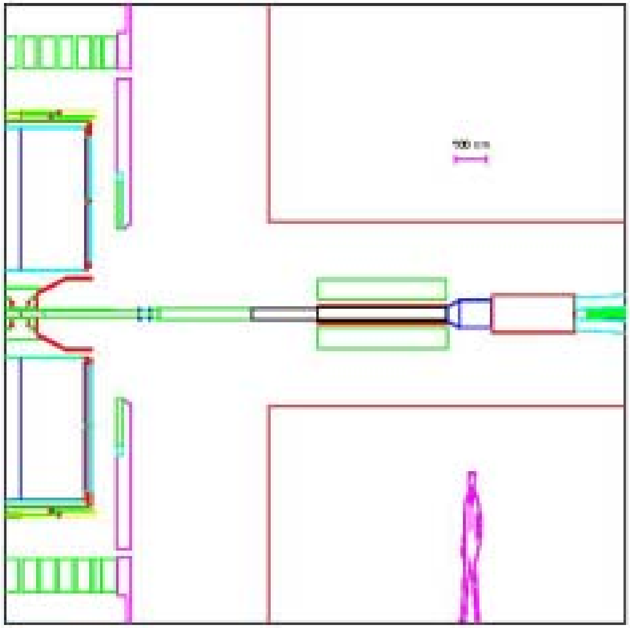
High Voltage has hardware interlocks similar to the SVT subsystem.

Front End Electronics has temperature-sensors to shut off low voltage in case of loss of chilled water.

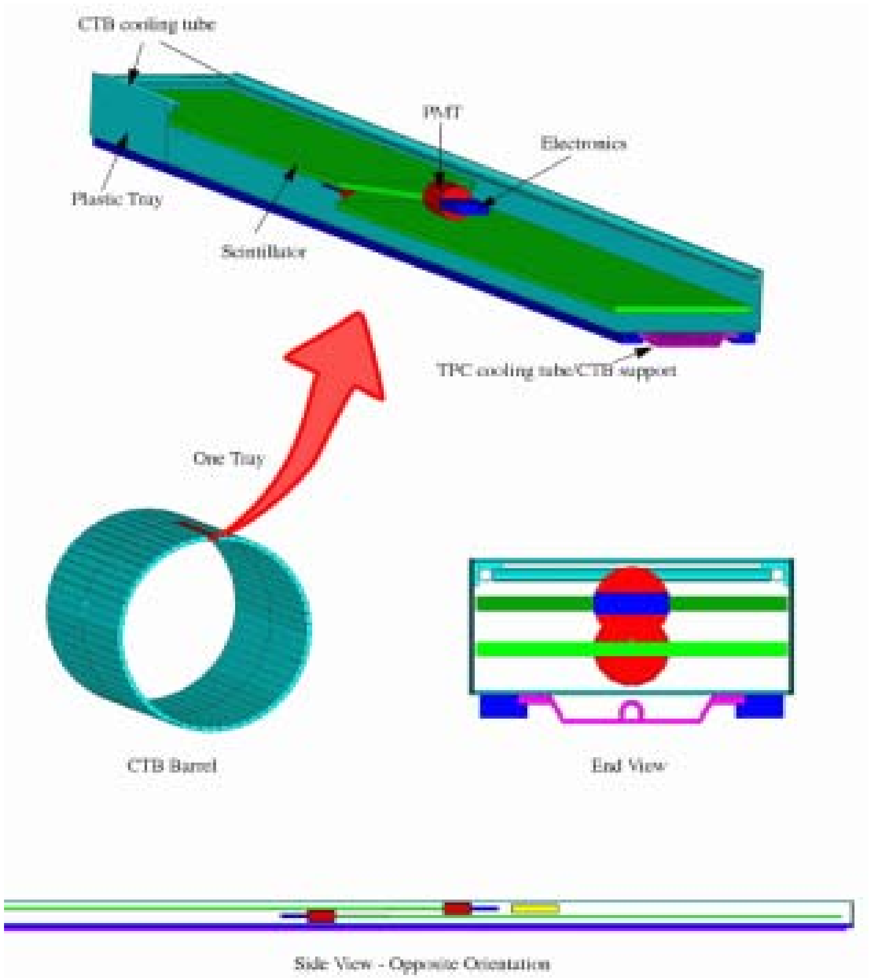
Gas system has a vent valve outside of the building in case of accidental overpressure of the supply line.

Sub Systems - Trigger

Zero Degree Calorimeters (ZDC) Coincidence.



Central Trigger Barrel (CTB) Summed ADC Threshold.



1. The CTB will operate with 119 of 120 trays installed.

2. a. The PMT voltages are from current limited LeCroy supplies set for maximum HV of 2200 V.

b. 10 VME crates operate at 220V and 2.3kW each.

3. no gases 4. no liquids

5. Proposal to add one veto paddle in front of ZDCs

Essentially No Changes from Last Year

Beam Beam Counter (BBC)

1. Configuration:

- System fully operational in FY04. No changes planned for FY05 run. PMT boxes have continuous thermal monitoring.

- Readout is via "trigger" electronics.

2. No gas system or water cooling.

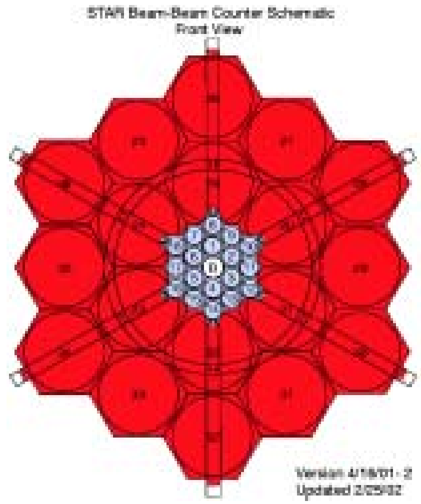
3. Voltages:

- The PMTs for the BBC operate at an average cathode voltage of -1400 V.

- The HV is supplied by a LeCroy 1440 system located on the South Electronics platform

4. Interlocks:

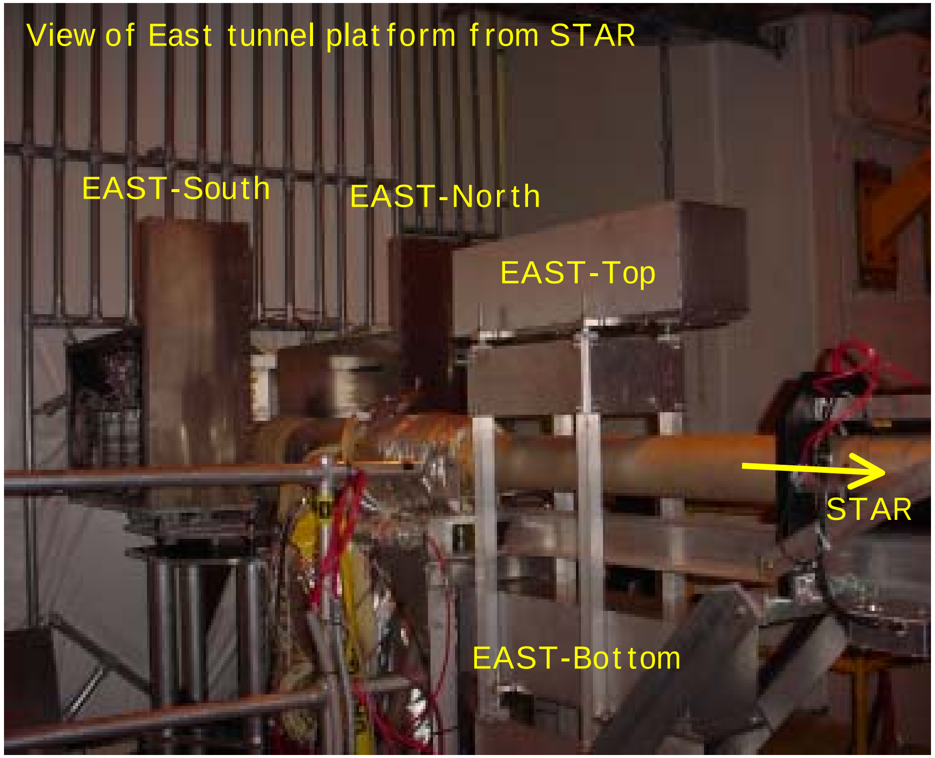
The electronics and HV systems for the BBC are housed in electronics racks on the South platform. These are standard STAR racks and have have standard STAR interlock features (e.g. rack based smoke and water leak protection, power shutdown via SGIS).



No changes for FY05 run

Forward Pion Detectors (FPDs)

STAR



1. Configuration:

Modular Pb-glass calorimeters positioned left, right, above and below the beam line on the east and west tunnel platform extensions. Planned additions for run 5 are the west-north and west-top calorimeters.

2. No gas system or water cooling for detector.

3. Voltages:

Typical voltages are -1700 V on photocathodes, supplied by LeCroy 1440 systems located on east and west walls of wide angle hall.

4. Interlocks:

Electronics and HV system are housed in racks located on east and west walls of wide angle hall. These racks have local smoke detection interlocked with AC power.

Patch TOF (TOFr) & VPDs

STAR

Time of Flight Patch (TOFp):

Removed from system, along with associated electronics, for FY05 run. Replaced with CTB tray.

Prototype Vertex Position Detector (PVPD)

- Each pVPD contains three PMTs
- Located on each side of STAR, on beampipe support
- New readout electronics for FY05 run.

Resistive Plate TOF patch (TOFr')

Layer of feedthrough plates+TOFr FEE replaced by new approach where the FEE layer also closes the box. This is how the full system will have to be. The FEE boards for TOFr' are called TFEEp and are exactly the same in terms of Voltage & Current draw etc as the TOFr FEE. They are just 'repackaged' 4 separate boards handling 1 MRPC module each) -> 1 board handling 4 MRPCs.

Gas System:

- R134A, 63ccm
- isobutane, 3.5ccm
- SF6, 0-3.5ccm

all vented to the atmosphere, outside through a stack

Voltages Used:

HV - +/-8kV, <50nA, total for MRPCs

LV - +/- 8V,

- 1.2V for disc threshold

Interlocks:

pVPD and TOFp systems: same as last year.

TOFr:

Power to racks is dropped upon loss of STAR global interlock. This drops HV and LV. Interlocks also in gas mixing room. Senses for isobutane content. Stop gas flow upon loss of SGIS gas permissive.

Procedures:

HV, LV, and gas system same as last year.

TOFr’ (additional Information).

Basically TOFr' is the same as TOFr but

- layer of feedthrough plates+TOFr FEE replaced by new approach where the FEE layer also closes the box. this is how the full system will have to be. the FEE boards for TOFr' are called TFEEp and are exactly the same in terms of volrtage & current draw etc as the TOFr FEE. they are just 'repackaged' 4 separate boards handling 1 MRPC module each) -> 1 board handling 4 MRPCs... all the same fusing and over-voltage and over-current protection in the TOFr FEE is also in TFEEp.

  this year we installing fewer modules in the tray and fewer TFEEp chs (compared to TOFr') so total voltage and current loads this year will be ~2/3 of what they were last year...

- mechanical design is vastly simpler, cleaner, and easy to build, and at the same time better electrically-mates the TFEEp to the box body (compared to the feedthrough plates used in TOFr) whic should provide better suppression of external RFI etc.. numerous holes that had to be plugged explicitly in TOFr to prevent gas leaks now do not exist. the tray feet are welded on now,

  since we are powering up less modules, we need less signal cables. the total weight of TOFr' should thus be ~5-10lbs lighter than TOFr.

- 5 out of the 6 TFEEp boards for TOFr' drive a small TTST board which drives logic signals over the platform for CAMAC digitization. TOFr' also devotes one TFEEp board to provide the detector signals to "Jalepeno" - the disigitizing board based on the CERN HPTDC that was developed by the Rice/Blue Sky SBIR-I and II projects... Jalepeno gets its power locally from the TFEEp LV bus. i am checking with the engineer on the voltage and curent draws.

  jalepeno needs the TCD information - so we have to run a cable from the TOFp TDC in Rack 1A-1 South to the TOFr' tray to bring the trg commands and tokens to jalepeno.

  Another 'canbus' cable brings the jalepeno information to a laptop sitting inside the TOFp racks.

  I attached a photograph of TFEEp (left) and Jalepeno (right)

  Mechanically jalepeno is solidly mounted directly above its TFEEp. a metal grill is mounted above jalepeno for protection. No special forced-air or water cooling is needed...

Overall - total heat, V/I load etc for TOFr' still less than for TOFr...

TOFr' (additional information).

Extended Sub System – Endcap EMC (EEMC)

Configuration: Full structure mounted on west STAR poletip; all twelve 30° sectors loaded with tower scintillator megatiles and extruded strip Shower Maximum (SMD) modules (Same as last year).

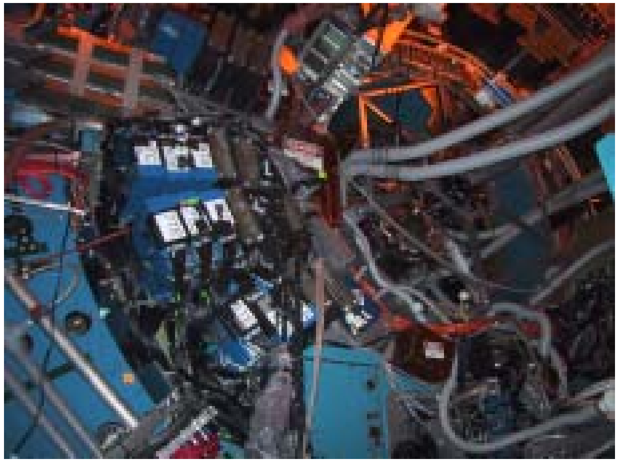
Instrumentation: Magnetically shielded PMT boxes and readout for all 720 towers (12 sectors) on back of poletip. Readout of Multi-Anode PMT boxes for all sectors of SMD, PreShower and PostShower layers.

Power & Interlocks: Supplies and electronics crates in rollaround racks w/ shore or platform power; local smoke alarm trips rack shunt breakers.

Voltages: HV (~ 1000V) for PMT/MAPMT supplied via CW bases; HVSys made controller supplies 160V and safety shutdown features; LV power (WIENER) supplied remotely to tower crates at ±5V, ±12V and MAPMT box FEE electronics via distribution panels at ± at 7V, +4V.

Water Cooling: MAPMT boxes cooled by commercial closed-loop chiller system with ~ 10 gallon total volume; local safety interlocks.

Laser: Nd/YAG (λ=355nm), primary 11mJ/pulse @ 10Hz; west tunnel operation enclosure, split and delivered via (closed) fiber distr network ; misc. monitoring PMT's, diodes and electronics

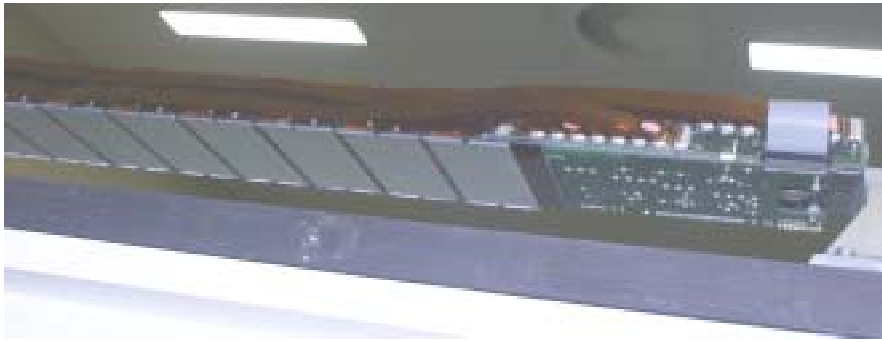


Sources: sealed 300 μCi ^{60}Co used only in test/calibr mode when poletip is removed from STAR; small alpha test sources enclosed in level #2 laser splitter boxes on back of poletip.

Extended Sub System - Silicon Strip Detector (SSD)

1. Configuration: 20 SSD ladders (10 ladders in FY04 Run).
(Full configuration = 1 barrel = 20 ladders = 320 wafers = 491,520 channels)

2. Voltages:
SSD Wafer : 50 V ($I_{op} < 200\ \mu A$, $I_{max} < 1$ mA)
FEE power : +/- 2V
ADC, Control and RDO power : +7V, +5V



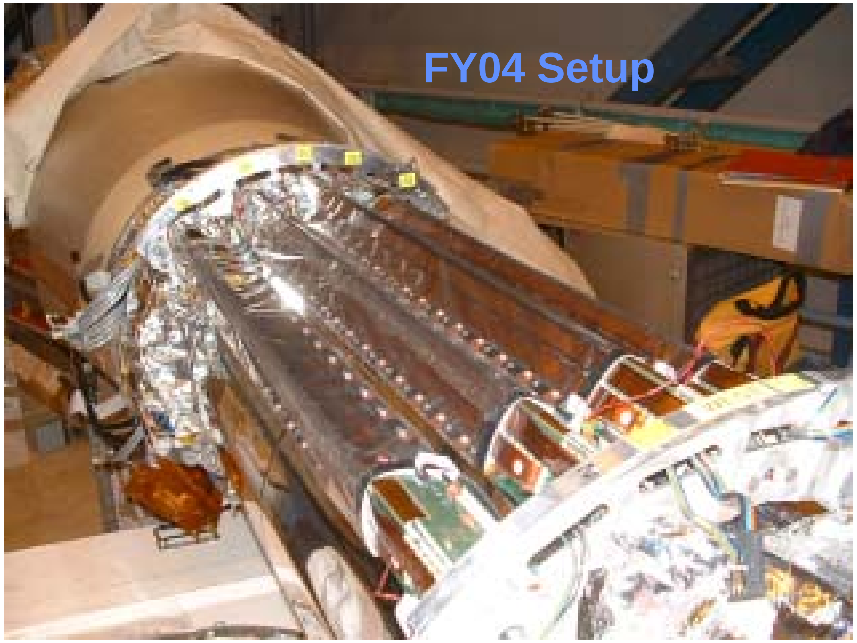
3. No water cooling or gas system.

4. Air cooling : The SSD ladders and its RDO boards are air-cooled. The air is taken from the IFC, pulled through the ladder and released to the WAH. Four vortex (transvector airflow amplifier) installed on the Pole Tips use 8 bars compressed air and induce an airflow (1 liter/s). The nominal temperatures are : 30°C on the wafers, 35°C on the ladder boards and 60°C on the RDO boards.

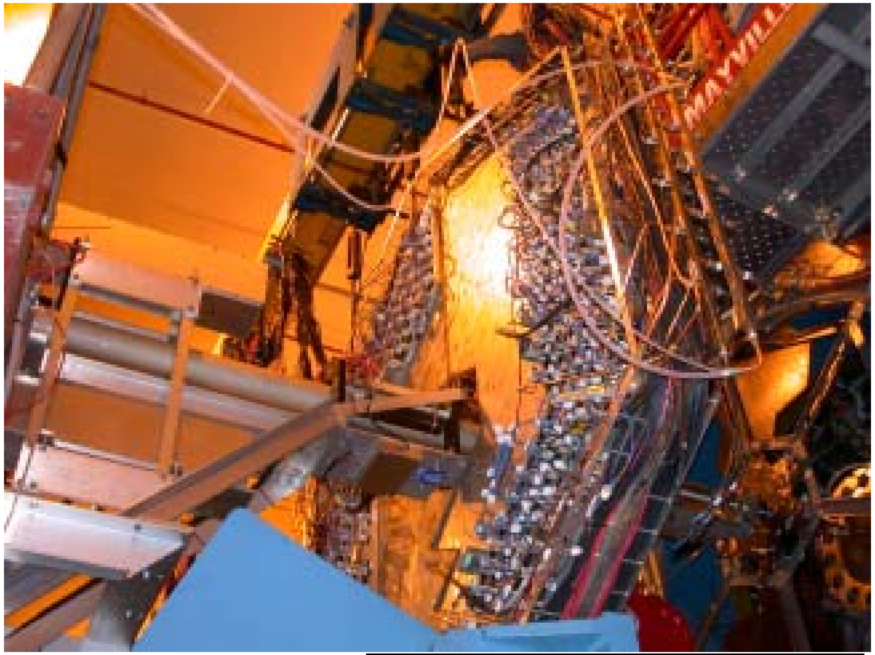
5. Interlocks : The SSD interlock system is closely linked to the SGIS. It uses a custom-made relay driven system integrated in the SSD slow control crate located on the STAR south platform. The SSD power supplies and the cooling system can be turn on only if the following permissions are granted :

- IFC permissive (from SGIS)

The internal Slow Control allows one to monitor the wafer and board temperatures and to turn off the SSD voltages in case of an air cooling system failure.



Photon Multiplicity Detector (PMD)



1. Configuration: Complete PMD detector in place for the FY05 run.

- All rack mounted electronics in place
- Full gas system in place
- Full beam support system in place
- 24 detector modules (complete system)

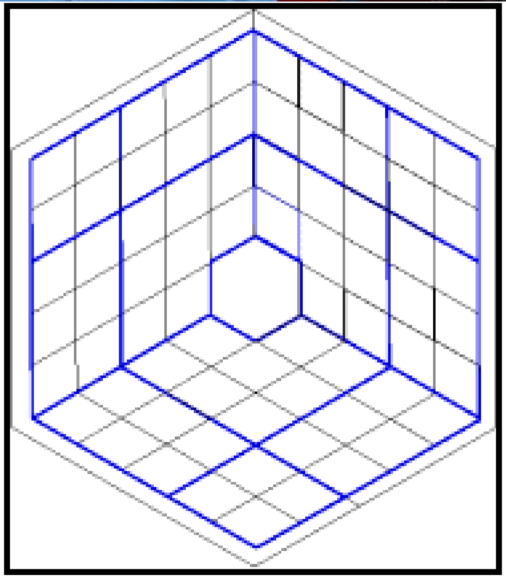
2. Gas System:

- PMD gas system is a single pass design. Same as used in FY04 run.
- Gas composition is 70% Argon & 30% CO_2
- Total flow rate is ~ 50 l/hour
- Gas is vented to gas mixing room

3. Voltages:

- HV is provided by LeCroy 1454 supply
- Detector is operated at - 1450 V
- LV is $\pm$ 2.7V, provided by Weiner commercial supply

The LV distribution box was redesigned during FY04 run with active current monitoring and tripping circuits.



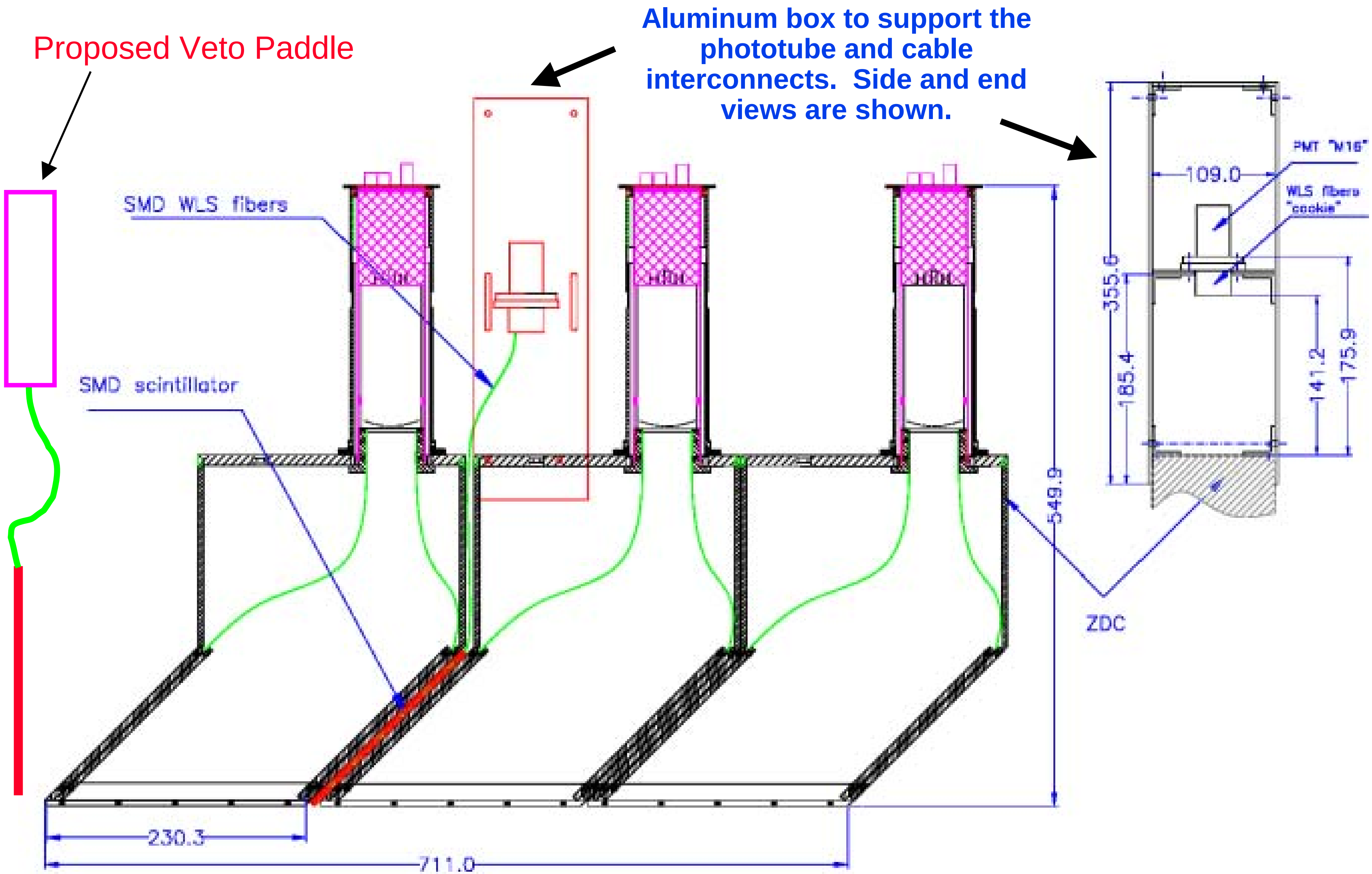
4. Interlocks:

- Local smoke interlock on racks, SGIS power crash button

5. Procedures:

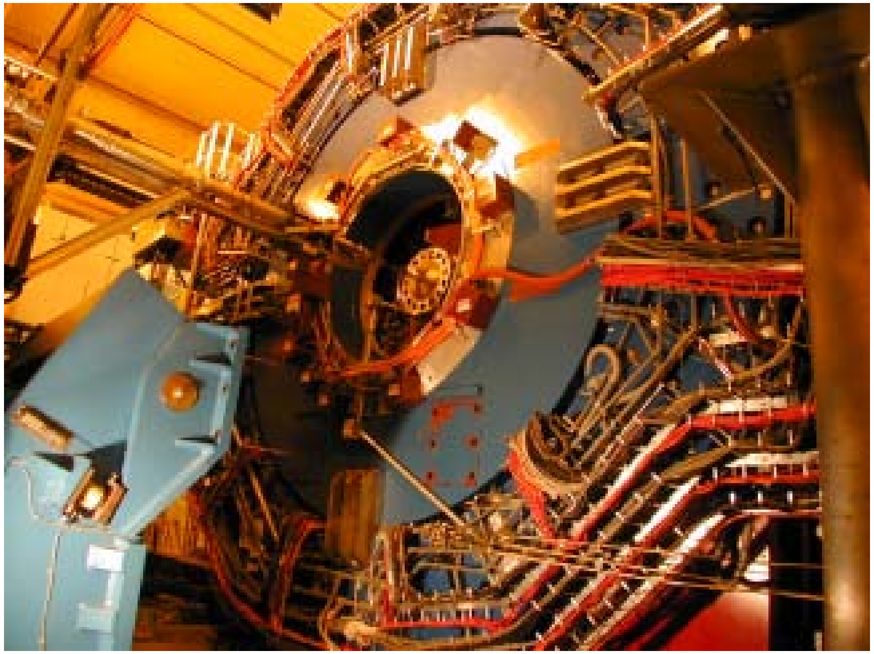
- System will be run by experts at start of FY04 run, with plan to turn over to shift crew during the running period.

Recent plans to install Veto which fits in front of the existing ZCAL elements



STAR Magnet Operation

- Due to a request from C-AD, efforts are underway to allow for the remote operation of the STAR Magnet by the Collider Operations group, during periods when there are no STAR Shift personnel at the STAR site.
- The Software Control system for running the STAR magnet is/has been modified by the C-AD Controls group. The modification is to allow only one group (i.e. either C-AD of STAR personnel) at a time to control the STAR magnet Power Supplies.
- Relevant Operations Procedures (OPMs) dealing with the STAR magnet have to be modified to account for this change in STAR magnet operations.
- There will also be a new feature added to the STAR Global Interlock system which will allow for ensuring protection against magnetic fields from the STAR magnet without the need to “rack out” the 13.8 kV line.



SGIS Interlock System

- Meeting will be held to discuss any necessary changes to SGIS system. At this point the only anticipated change is the addition of the feature (keyswitch) to ensure safety against STAR magnetic fields without the need to “rack out” 13.8 kV switch.

- Schedule calls for SGIS interlocks system certification (I.e. “Blue sheet”) to be completed by October 4th.

Summary

Note: Environmental Emissions Document is complete for FY05

Still Pending:

- **PMD, BEMC, EEMC, and SSD likely to be initially operated by experts at start of FY04 run, and then turned over to shift crew.**
- **Get SGIS updated (as/if necessary) and certified.**
- **Update Magnet procedures to account for remote (C-AD) magnet operation**